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INTRODUCTION

While fishery development activities in the Northwestern Hawaiian Islands and a return to modernized traditional handline methods in the main islands have been widely heralded in Hawaii, a quiet explosion has occurred in the fresh mahimahi (dolphin), Coryphaena hippurus, and ono (wahoo), Acanthocybium solandri, markets. Mahimahi has long been considered the "State fish" in the tourism sector, but most of which that appeared on visitor plates was a frozen product imported from Taiwan, Ecuador, or Peru. Local production of both species was low in the 1960's. However, in 1973, catches and prices of both species began to rise dramatically to the point where fresh mahimahi or ono dinner entrees now frequently go for over $14.00 in local restaurants, and the selection in supermarkets and retail fish shops has become severely limited because of strong restaurant demand.

Recognizing the unique aspects of this situation, the Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, sponsored a study in 1982 of marketing changes for these two white-flesh pelagic fishes. The study was undertaken by B.T. & Associates, a firm closely associated with the Honolulu fresh-fish auction and Hawaii's other seafood markets. Their study was issued in 1983 as Southwest Fisheries Center Administrative Report H-83-6C. Takenaka, principal investigator, and Torricer provided the marketing text, and Cooper and Pooley provided statewide landings results for this report.

Other information on mahimahi and ono is extremely limited and only two informal marketing reports have been written in Hawaii.[1,2]

History

Mahimahi and ono are frequently caught by longline vessels and domestic trollers. Relative to other locally-caught species, fresh mahimahi has been a fairly high priced item in Honolulu restaurants since the 1960s. A Honolulu family restaurant located away from the heart of Waikiki, was long noted for its fresh mahimahi, but their supply of fish was uneven and inconsistent. Frozen mahimahi frequently appeared as "fresh" mahimahi at restaurants which catered to tourists, whereas the local market emphasized red-flesh fish such as skipjack tuna, Katsuwonus pelamis, and yellowfin tuna, Thunnus albacares. Ono was seldom served in restaurants before the mid-1970's.

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[1]Char, R. 1978. Mahimahi imports, exports and consumption in the State of Hawaii. Prepared for Western Pacific Regional Fishery Mangement Council, 10 p.

[2]Evering, G. C. 1980. The supply of Coryphaena hippurus in the State of Hawaii. Department of Agricultural Economics, University of Hawaii, 18 p. (Unpublished paper.)

In 1970, commercial landings of mahimahi in Hawaii were only 75,000 pounds while ono landings were 45,000 pounds (Tables 1 and 2). This contrasted with earlier periods in which the combined landings of both species were 300,000 pounds (1950). By 1979 mahimahi landings had risen to 165,000 pounds and ono landings to 200,000 pounds exceeding the post-war peak. Meanwhile, the average ex-vessel price of mahimahi had risen from $0.72 per pound in 1970 to as much as in 1979, despite the large increase in supply. The inflation-adjusted average price has increased 29% over the decade. The average ex-vessel price of ono has increased from $0.27 a pound in 1970 to $1.53 in 1979 (rising 200% in inflation-adjusted average prices). The combined revenue of locally-caught fresh mahimahi and ono increased tenfold in real terms (inflation-adjusted) over the last decade, and the statewide reported sales were $587,000 in 1979.

At the Honolulu auction, where premium prices are awarded to high quality fresh fish, the number of fish going through the auction has increased dramatically, from 4,500 in 1975 to 15,300 in 1981. Total value rose from $151,000 to $690,000 during the same period (Tables 3 and 4). The auction price per pound of fresh mahimahi exceeds $5.00 in months of low availability.

The availability of mahimahi in Hawaiian waters is distinctly seasonal with peaks in abundance during the spring (March and April) and the fall (October and November) (Fig. 1). The small boat operations which characterize Hawaii's commercial fishery in the main islands are sustained by a diversity of fish resources. Fishing effort is applied to those species considered most abundant, and considerably less effort is applied in the off-season. The smallest number of fresh mahimahi pieces is sold in the winter months, usually December or January, when waters are rough and when demand for bottom fish and ahi (yellowfin tuna, T. albacares, and bigeye tuna, T. obesus) reaches its peak.

The seasonality of fresh mahimahi is confirmed by an analysis of Hawaii Division of Aquatic Resources (HDAR) monthly landings records (Fig. 1). An autoregressive, interative moving average (ARIMA) program using the Box-Jenkins method of identifying cyclical patterns in periodic data was applied to statewide landings. This program looks for and identifies regular cycles in data in which such characteristics may not be apparent. Results of the identification phase of ARIMA on the weekly weight landed, revenue and average price for the period 1976-80 are shown in Figures 2-4. The figures show the correlation of a current weeks value with each of 64 previous weeks. All three series show undamped cyclical behavior and lags of 26-28 and 52 weeks. The price variable shows a significant peak at lag 28 which indicates that the price of mahimahi in any 1 week is positively correlated ($r = 0.193$) with the price of mahimahi 28 weeks (6 months) earlier. The revenue and weight sold variables show significant peaks at 26 weeks ($r = 0.389$ and 0.358, respectively). This periodicity confirms a definite semiannual seasonality falling within the April and October range identified by the auction data. The 52-week lag corresponds to year-to-year influences on availability and price, as would be expected (positive correlations of 0.308, 0.239, and 0.278, respectively).

Although mahimahi can bring $4.50-$5.00 per pound to the vessel during the off-season, more important for the long-term income of fishermen is the base price level. In 1981 the lowest average monthly price was $1.94, considerably above previous lows. The United Fishing Agency data indicate that the quantity demanded for fresh mahimahi, as measured by total weight sold, has increased by 128% since 1975. Harvesting of this species continues to be more attractive each year, and even with rising prices, wholesale dealers demand is high.

Like mahimahi, the availability of ono is also seasonal and most are landed during the summer months (Fig. 5). Little of either is available in January or February while in the other months their different seasonality patterns partially balance supply.

A 1979 wholesale market survey by the National Marine Fisheries Service showed that 42 firms handled fresh and frozen mahimahi (worth $10.6 million in 1979) and 23 firms handled ono.[3] Wholesale revenue was $10.6 million for mahimahi (fresh and frozen) and $1.3 million for ono. Both species are sold throughout the retail sector. A 1982 survey of supermarkets, restaurants, and institutional markets provided an estimate of $16 million sales of mahimahi (8.7 million pounds) and $3.7 million of ono (1.2 million pounds) in Hawaii. (Unpublished data, NMFS.)

THE MARKET

Four factors have been identified with the increasing demand for fresh mahimahi and ono in Hawaii, some of which are local in scale and some of which are nationwide trends. These include:

* A general increase in overall seafood consumption due to health considerations.
* A growing population in Hawaii of people with preferences for white-flesh fish.
* The popularity of the "Hawaii" label in mainland U.S. markets.
* Convenient preparation.

Health

The advantages of eating fish over red meats have been widely recorded may have increased the acceptance of fish as a restaurant meal. In the area of health, seafood consumption has risen dramatically in the past 10 years, favoring fresh and frozen seafood products.

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[3]Cooper, J. C., and S. G. Pooley. 1982. Total seafood volume in Hawaii's wholesale fish markets. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812, Admin. Rep. H-82-15, 12 p.

Demography

There seems to be a cultural correlation between the ethnic groups which reside in Hawaii and their preference for fish. Many Asian, Hawaiian, and other non-Caucasian groups have always had a definite preference for red-fleshed fish whereas Caucasians prefer white-fleshed fish. The ethnic composition of Hawaii's seafood eating population began to change dramatically in 1970, especially through the growth of up-scale seafood restaurants catering to tourists (of whom there were 4 million in 1982).

Familiarity

Awareness of mahimahi and its seasonal availability caused a greater demand for the species. Primarily as a result of the competitive nature of the restaurant business, fresh mahimahi became established as a menu item among the exclusive restaurants in Honolulu. Tourists and new residents were introduced to other species of white-fleshed fish through their initial experience with fresh mahimahi, supplies of which continued to be inconsistent or seasonal. More people began to prefer and request fresh fish, more restaurants began serving fresh seafood, restaurant chefs learned how to prepare mahimahi according to the taste preferences of tourists, and the fish wholesale and distribution network expanded to provide the fresh product.

Tourism

The primary market for fresh mahimahi in Hawaii remains Honolulu, the population and tourist center. The development of Maui as a tourist center (over 1 million tourists annually) has created a large secondary market for fresh mahimahi and has created new conditions for commercial fisheries development on that island.

The "Hawaii" Label

Exports of mahimahi and ono to the U.S. mainland have just begun, riding the acceptance of the "Hawaii" label in mainland markets. Visitors to Hawaii and military personnel returning home advise others about fresh mahimahi. Television and printed media advertising promote the Hawaii label, and a variety of products are increasingly marketed as "made in Hawaii." These circumstances have made possible high-priced export markets for fresh mahimahi, as well as for other white-fleshed fish (such as ono and opakapaka, Pristipomoides filamentosus). The ability to export to the mainland U.S. market has assisted the Hawaii commercial fishery by maintaining demand during periods of seasonal abundance (April and October), so that gluts do not greatly depress prices in the local fish market.

Preparation

The marketing and processing capabilities of the Hawaii seafood industry have expanded significantly since 1975. Fresh mahimahi is

routinely filleted by wholesale dealers for sale to restaurants. The boneless fillets are a highly convenient product for use by restaurant chefs. The chefs need only cut individual meal sized (6 oz) portions of fish from the fillets, and this savings in labor is an important economic advantage for the restaurants. Although the yield of saleable product from mahimahi is similar to that from opakapaka and other species used in restaurants, the body shape and average size of individual fish make it somewhat easier to prepare.

The shelf life of freshly caught mahimahi is 5 to 7 days, and most restaurants usually maintain an inventory of mahimahi, which is frozen for short periods. In placing orders with wholesalers, restaurant purchasing agents have to balance their previous investment in inventory against current availability and price. A restaurant having little inventory may have to pay higher than average prices to assure availability of fresh mahimahi. The variability in supply and price, coupled with steady demand, causes the price and also the profit margin of a fresh mahimahi dinner at a Waikiki restaurant to fluctuate considerably throughout the year. Restaurants can list frozen mahimahi dinners on their menus at a fixed price but usually sell fresh mahimahi dinners at a fluctuating price.

Fresh Ono

The gap in total landings and revenues which existed between fresh mahimahi and fresh ono as recently as 1975 is closing rapidly (Table 1-4). The explanation for the sharp rise in the demand and price for ono is that this species has been perceived as a close equivalent to mahimahi by the restaurants which serve fresh white-fleshed fish and has found market acceptance. Since it is not possible for restaurants to offer fresh mahimahi throughout the year, chefs have looked to other white-fleshed fish as substitutes. However, unlike mahimahi, the other species are generally not available in frozen form as a backup to the fresh product. Therefore, ono, opakapaka, ulua (Carangidae), swordfish, Xiphias gladius, and other species which complement or substitute for the more popular mahimahi are generally served as "fish of the day" or as specials. The price of a fresh ono dinner at one popular restaurant has increased from $7.50 to $12.00 over the past 4 years.

All of the white-meat species upon which restaurants rely are subject to seasonal variation in availability, so it is necessary for chefs to rely on the full array of available products. Their purchases are based on the affordability, as well as the availability, of the preferred species. Because the seasonal abundance of fresh mahimahi and ono in Hawaiian waters does not overlap, there is only limited market competition between the species.

Frozen Imports

Noting the rising demand for the "State fish" but the lack of a consistent supply, one or two Honolulu wholesalers in 1970-71 began to make speculative purchases of frozen mahimahi in Japan for import to

Hawaii. Mahimahi is not a popular fish in Japan or Taiwan, but it is caught in large quantitites by those nations' distant-water tuna longline fleets. Through bulk purchasing, the Honolulu buyers were able to obtain low prices and uniformity of the frozen product in filleted form.

The availability of a consistent supply of frozen fillets made it possible for exclusive restaurants to back up the limited fresh fish supply and to place mahimahi on the menus with assurance. The low cost of the frozen imported product gave fast-food and general public restaurants the opportunity to serve mahimahi as a low budget menu item. The only way to provide every tourist with the experience of eating the best known fish in Hawaii is through frozen fillets. Char's report noted that a large hotel chain purchased 240,000 pounds of frozen mahimahi and another hotel chain 80,000 pounds in 1977. Although frozen fillets are sold through retail markets, they are most widely used by the large number of restaurants which serve the general public, rather than an exclusive clientele.

Evering (see footnote 2) estimates that imports of frozen mahimahi fillets rose to 6 million pounds in 1980, compared with an average of 2.6 million pounds per year before 1975. These estimates are based on the amount of undifferentiated frozen fish fillets imported from Japan and Taiwan as reported by the U.S. Customs Service. Mahimahi is not separately recorded but quantities can be inferred by a process of elimination. Taiwan supplies most of the imports. Smaller quantities are shipped from Japan, and some mahimahi fillets originate in Latin America. During the summer months, Hawaii distributors rely on large amounts of frozen fillets imported from Taiwan and Japan. Frozen fillets from Latin America augment the reduced supply from Asian nations during the winter. However, Taiwan mahimahi is considered to have better quality than that from other sources and is thus preferred. The declared value of frozen mahimahi imports from Taiwan and Japan averaged $0.76 per pound in 1980, compared to an average sales price of $2.41 per pound (round weight) for fresh mahimahi sold through the fish auction.

Frozen mahimahi is becoming a more expensive source of protein because of the extra cost of meeting quality standards. Nevertheless, demand does not appear to be slackening for this product. Furthermore, because of the major differences in the price for fresh and frozen mahimahi (perhaps a sixfold magnitude for equivalent servings), the fast-food and general public restaurants which are the major buyers of the frozen fillets are not generally able to substitute fresh mahimahi if their frozen supply is interrupted.

Mahimahi is shipped to Hawaii as frozen, skin-on, boneless, trimmed fillets, which are often graded and priced by weight gradations. In the initial years of import, wholesalers could purchase the frozen fillets for about $0.30 per pound, but in recent years, the price has been $0.75-$0.80 per pound. Retailers pay about $1.00-$1.20 per pound. In recent years, seven major wholesalers and a good number of smaller wholesalers have been involved in importing mahimahi from Taiwan. A standard order from one wholesaler is one container (30,000 pounds) per month. Most wholesale

dealers use a broker who combines orders. The Taiwan fillets are distributed directly to retailers, whereas the fillets from Latin America arrive in larger lots (250,000 pounds) and are frequently held in storage and withdrawn when supply is short.

In April 1979, a case of histamine poisoning in Hawaii was attributed to mahimahi imported from Taiwan. The U.S. Food and Drug Administration (FDA) delayed the sale of approximately 25% of incoming shipments of frozen mahimahi until tests were made. Histamines are difficult to detect because their presence is far from uniform in batches of fish. The risk of histamine poisoning is reportedly greatly increased by poor handling of mahimahi by exporters. In the summer and fall of 1980, there were several more incidents of histamine poisoning, and every container of frozen fillets was blocklisted by the FDA. This means that all shipments into the U.S. are now detained until the importer can prove that the shipment conforms to required sanitary standards by means of independent laboratory analysis.

There is no discrimination in FDA testing of mahimahi fillets from various origins. Although the testing of samples is usually completed within a few days after seizure, the FDA may take several months to review the laboratory results before allowing release of the frozen fish for sale. Not only are distributors' initial costs for fish purchases tied up, but storage fees are incurred during the delays. The cost of the delay, plus the loss of several lots of the product rejected by the FDA, caused many dealers to stop handling imported mahimahi. There was a reduction in imports from Taiwan and Japan in 1980, possibly caused by the confusion in the market. The reduction forced some buyers to accept New Zealand snapper fillets as a substitute for mahimahi in the spring of 1981.

Frozen ono is not widely available in world landings so no import system has developed in Hawaii. Ono is sometimes brought from India and other parts of Asia as frozen steaks or fillets, but a steady supply is not available. Ono is also landed and canned in American Samoa where it is considered a local delicacy.

CONCLUSION

The rising demand for locally caught, fresh mahimahi is a result of its acceptance among the Caucasian tourist and resident populations of Hawaii, and the strong association of this species with the "Hawaii" label. The shift toward greater seafood consumption among a health-conscious American population has contributed to greater awareness and preference for fresh seafoods in general.

Fresh and frozen products have unique markets. The great demand in restaurants for fresh mahimahi has caused the price to rise, stimulating an increase in fishing effort for this species. The bulk of the fast-food and general public restaurants in Hawaii cannot afford to put high-priced fresh mahimahi on their menus, but large imports of frozen mahimahi fillets have made low-budget meals feasible for such establishments. Independent seafood markets cannot do without either product.

Fresh ono is rapidly gaining the same market acceptance and status as fresh mahimahi in the restaurants which serve white-meat fish to tourists. The supply of fresh ono may not be as limited as that of fresh mahimahi, but the price of both is expected to continue climbing as long as the tourist experience in Hawaii includes a fresh-fish dinner. In fact, market opportunities may exist for other white-meat species if they could gain market recognition and acceptance comparable to mahimahi and ono.

Competition may arise from imports of other white-meat fish, such as California rockfish (Scorpaenidae). At the same time, a decline in the demand for fresh mahimahi due to a decline in Hawaii's tourism industry would have major repercussions on the market situation. Therefore, although the local mahimahi and ono fisheries have been rejuvenated over the past 5 years, the situation is not necessarily sanguine.

Table 1.--Mahimahi annual landings statewide.

YEAR	CATCH IN THOUSANDS OF POUNDS	CATCH IN METRIC TONS	REVENUE IN THOUSANDS OF DOLLARS	DEFLATED REVENUE IN THOUSANDS OF DOLLARS	ADJUSTED REVENUE IN THOUSANDS OF DOLLARS
1949	170.7	77.4	58.29	83.63	212.26
1950	276.1	125.2	81.70	122.13	309.96
1951	211.4	95.9	69.51	97.90	248.47
1952	187.1	84.9	70.04	95.82	243.19
1953	162.6	73.7	66.73	90.54	229.79
1954	235.8	106.9	77.23	103.81	263.47
1955	265.5	120.4	85.66	113.60	288.33
1956	183.6	83.2	68.43	89.57	227.33
1957	209.8	95.2	72.00	91.14	231.31
1958	149.0	67.6	57.83	69.85	177.28
1959	108.7	49.3	49.12	58.33	148.05
1960	90.6	41.1	50.17	58.13	147.53
1961	116.4	52.8	47.75	53.90	136.79
1962	109.0	49.4	46.63	51.46	130.61
1963	127.2	57.7	52.00	56.16	142.53
1964	85.4	38.7	46.56	50.12	127.20
1965	91.3	41.4	48.05	50.79	128.92
1966	85.4	38.7	41.36	42.51	107.88
1967	72.1	32.7	42.07	42.07	106.78
1968	73.5	33.4	49.29	47.49	120.53
1969	58.5	26.5	53.70	49.49	125.60
1970	76.1	34.5	54.82	48.00	121.83
1971	114.8	52.1	73.77	62.05	157.47
1972	175.2	79.5	115.01	93.65	237.69
1973	114.4	51.9	94.29	73.50	186.53
1974	111.4	50.5	108.27	76.30	193.64
1975	117.5	53.3	115.19	74.32	188.62
1976	139.1	63.1	178.40	109.58	278.12
1977	150.3	68.2	223.80	130.27	330.62
1978	130.8	59.3	217.45	117.67	298.64
AVERAGE	140.0	63.5	80.50	76.79	194.90

Table 2.--Ono annual landings statewide.

YEAR	CATCH IN THOUSANDS OF POUNDS	CATCH IN METRIC TONS	REVENUE IN THOUSANDS OF DOLLARS	DEFLATED REVENUE IN THOUSANDS OF DOLLARS	ADJUSTED REVENUE IN THOUSANDS OF DOLLARS
1949	49.0	22.2	15.98	22.93	58.19
1950	48.6	22.0	10.58	15.82	40.15
1951	38.8	17.6	10.48	14.75	37.45
1952	49.1	22.2	11.74	16.06	40.76
1953	50.8	23.0	11.17	15.15	38.46
1954	34.8	15.8	7.20	9.68	24.56
1955	38.8	17.6	8.13	10.79	27.37
1956	30.2	13.7	7.42	9.71	24.66
1957	31.3	14.2	7.23	9.15	23.22
1958	39.2	17.8	7.68	9.28	23.55
1959	30.1	13.7	6.40	7.60	19.28
1960	23.9	10.8	5.72	6.63	16.83
1961	25.4	11.5	5.07	5.72	14.53
1962	24.4	11.0	4.60	5.08	12.90
1963	29.8	13.5	5.47	5.91	15.00
1964	33.1	15.0	6.43	6.92	17.57
1965	31.0	14.1	6.09	6.43	16.33
1966	22.3	10.1	4.94	5.08	12.89
1967	39.2	17.8	8.60	8.60	21.82
1968	28.2	12.8	6.64	6.39	16.23
1969	35.2	15.9	9.27	8.54	21.68
1970	44.4	20.1	12.13	10.62	26.95
1971	39.2	17.8	12.02	10.11	25.67
1972	52.9	24.0	17.51	14.26	36.20
1973	75.7	34.4	30.91	24.09	61.15
1974	72.6	32.9	32.81	23.12	58.68
1975	114.4	51.9	67.05	43.26	109.79
1976	169.6	76.9	127.29	78.19	198.45
1977	223.4	101.3	203.81	118.64	301.10
1978	195.0	88.4	225.26	121.90	309.37
AVERAGE	57.3	26.0	29.85	21.68	55.03

Table 3.--Recent trends in annual mahimahi transactions, United Fishing Agency, Ltd., Honolulu, Hawaii.

	Year			
	1975	1979	1980	1981
Total number	3,918	7,814	8,687	10,957
Total weight (pounds)	75,965	112,832	142,158	173,135
Average weight per fish	19.39	14.44	16.37	15.81
Total value	$139,101	$242,407	$341,653	$440,749
Average price (current value)	$1.83	$2.15	$2.41	$2.55

Table 4.--Recent trends in annual ono (wahoo) transaction, United Fishing Agency, Ltd., Honolulu, Hawaii.

	Year			
	1975	1979	1980	1981
Total number	599	1,903	3,429	4,318
Total weight (pounds)	19,023	50,792	85,749	102,139
Average weight per fish	31.76	26.70	25.01	23.65
Total value	$12,782	$104,598	$183,891	$251,097
Average price	$0.67	$2.06	$2.15	$2.46

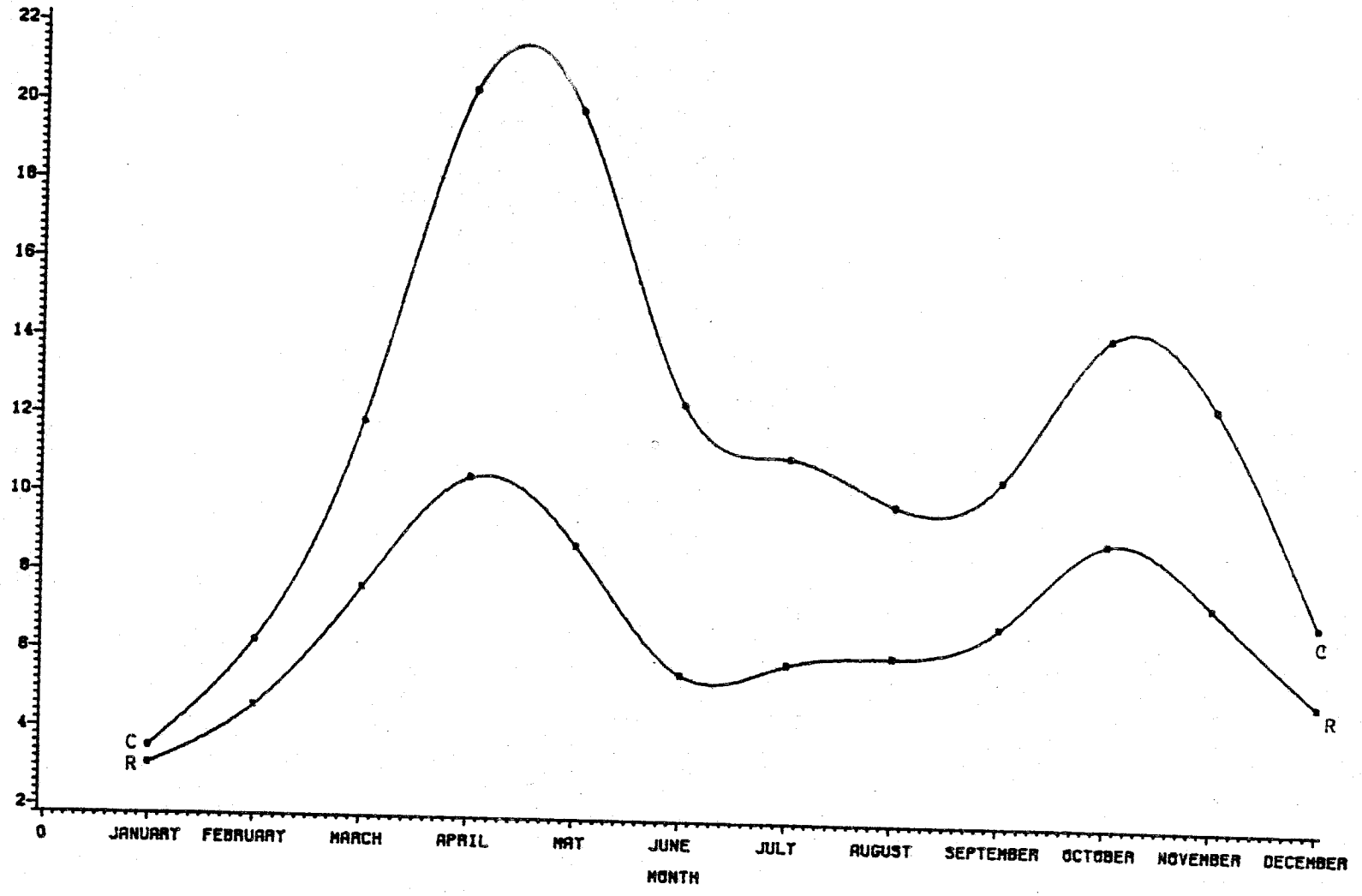

Figure 1.--Mahimahi monthly landings statewide. Catch (C) in thousands of pounds and revenue (R) in thousands of dollars. (Average 1949-78.)

Lag in months	Correlation between lagged and current month	Graph of correlation -1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
0	1.00000	**********
1	0.48998	.*********
2	0.39187	.********
3	0.30905	.******
4	0.43103	.*********
5	0.23214	.*****
6	0.05377	.* .
7	-0.00638	. .
8	-0.02552	. * .
9	0.00744	. .
10	-0.14069	.*** .
11	-0.17474	.*** .
12	-0.21156	**** .
13	-0.02472	. .
14	-0.20177	**** .
15	-0.20148	**** .
16	-0.24330	***** .
17	-0.10680	. ** .
18	-0.12125	. ** .
19	-0.09874	. ** .
20	-0.05061	. * .
21	-0.01693	. .
22	0.13976	. ***.
23	0.15396	. ***.
24	0.16506	. ***.
25	0.19248	. ****
26	0.38956	. ********
27	0.33874	. *******
28	0.23722	. *****
29	0.19898	. ****.
30	0.22547	. *****
31	0.16548	. *** .
32	0.02471	. .
33	-0.01117	. .
34	-0.05332	. * .
35	-0.04985	. * .
36	-0.17567	.**** .
37	-0.15653	. *** .
38	-0.15788	. *** .
39	-0.04328	. * .
40	-0.14113	. *** .
41	-0.15303	. *** .
42	-0.15404	. *** .

Figure 2.--Autogressive iterative moving average (ARIMA): Mahimahi landings (pounds): monthly 1976-80. The "." marks two standard errors. The "*" marks the correlation.

Lag in months	Correlation between lagged and current month	Graph of correlation -1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
43	-0.07718	. ** .
44	-0.03105	. * .
45	-0.07715	. ** .
46	-0.02489	. .
47	0.02598	. * .
48	0.17892	. **** .
49	0.12314	. ** .
50	0.20923	. **** .
51	0.19686	. **** .
52	0.30858	. ******
53	0.20923	. **** .
54	0.21074	. **** .
55	0.10208	. ** .
56	0.09654	. ** .
57	0.08103	. ** .
58	0.00796	. .
59	-0.08855	. ** .
60	-0.11052	. ** .
61	-0.07840	. ** .
62	-0.20091	. **** .
63	-0.21737	. **** .
64	-0.26131	.***** .

Figure 2.--Continued.

Lag in months	Correlation between lagged and current month	Graph of correlation -1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
0	1.00000	**********
1	0.46502	*********.
2	0.36913	*******.
3	0.32821	*******.
4	0.47812	**********.
5	0.28968	******.
6	0.14241	***.
7	0.11975	**.
8	0.11167	**.
9	0.16035	***.
10	0.01344	.
11	0.01062	.
12	-0.02573	*.
13	0.17881	****.
14	-0.02073	.
15	-0.01660	.
16	-0.05337	*.
17	0.07404	*.
18	0.04099	*.
19	0.03731	*.
20	0.05670	*.
21	0.08639	**.
22	0.21656	****.
23	0.17447	***.
24	0.15823	***.
25	0.16238	***.
26	0.35778	*******.
27	0.26857	*****.
28	0.20097	****.
29	0.18041	****.
30	0.21125	****.
31	0.17749	****.
32	0.06482	*.
33	0.04433	*.
34	0.01618	.
35	0.02145	.
36	-0.10775	**.
37	-0.06672	*.
38	-0.09270	**.
39	0.03262	*.
40	-0.06797	*.
41	-0.05982	*.
42	-0.06950	*.

Figure 3.--Autogressive iterative moving average (ARIMA): Mahimahi revenue ($): monthly 1976-80. The "." marks the two standard errors. The "*" marks the correlation.

Lag in months	Correlation between lagged and current month	Graph of correlation -1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
43	-0.00965	. .
44	0.02219	. .
45	-0.00827	. .
46	0.01626	. .
47	0.02903	. * .
48	0.16575	. *** .
49	0.09456	. ** .
50	0.15940	. *** .
51	0.13943	. *** .
52	0.23990	. *****
53	0.11598	. ** .
54	0.14421	. *** .
55	0.05763	. * .
56	0.03880	. * .
57	0.04491	. * .
58	-0.01409	. .
59	-0.07482	. * .
60	-0.10972	. ** .
61	-0.04909	. * .
62	-0.14834	. *** .
63	-0.12393	. ** .
64	-0.18073	.**** .

Figure 3.--Continued.

Lag in months	Correlation between lagged and current month	Graph of correlation -1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
0	1.00000	**********
1	0.76659	**********
2	0.62083	**********
3	0.51347	**********
4	0.41215	********
5	0.31869	******
6	0.22165	****.
7	0.14201	*** .
8	0.04682	* .
9	-0.01226	.
10	-0.04813	* .
11	-0.10313	** .
12	-0.11433	** .
13	-0.14843	*** .
14	-0.14304	*** .
15	-0.11505	** .
16	-0.08788	** .
17	-0.07266	* .
18	-0.03673	* .
19	-0.01757	.
20	0.02067	.
21	0.06290	* .
22	0.12613	*** .
23	0.12199	** .
24	0.13956	*** .
25	0.15774	*** .
26	0.17186	*** .
27	0.17725	****.
28	0.19312	****.
29	0.18311	****.
30	0.18944	****.
31	0.13433	*** .
32	0.06671	* .
33	0.02041	.
34	0.03340	* .
35	0.02783	* .
36	0.01281	.
37	-0.00518	.
38	-0.03213	* .
39	-0.05783	* .
40	-0.06071	* .
41	-0.07204	* .
42	-0.04260	* .

Figure 4.-- Autogressive iterative moving average (ARIMA): Mahimahi prices ($): monthlly 1976-80. The "." marks two standard errors. The "*" marks the correlation.

Lag in months	Correlation between lagged and current month	Graph of correlation -1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
43	-0.02181	. .
44	0.00149	. .
45	0.05169	. * .
46	0.09982	. ** .
47	0.13804	. *** .
48	0.15576	. *** .
49	0.17251	. *** .
50	0.20528	. **** .
51	0.22458	. **** .
52	0.27817	. ******
53	0.24020	. *****.
54	0.20668	. **** .
55	0.16967	. *** .
56	0.17726	. **** .
57	0.15326	. *** .
58	0.08565	. ** .
59	0.03034	. * .
60	-0.02679	. * .
61	-0.08103	. ** .
62	-0.10165	. ** .
63	-0.13104	. *** .
64	-0.12001	. ** .

Figure 4.--Continued.

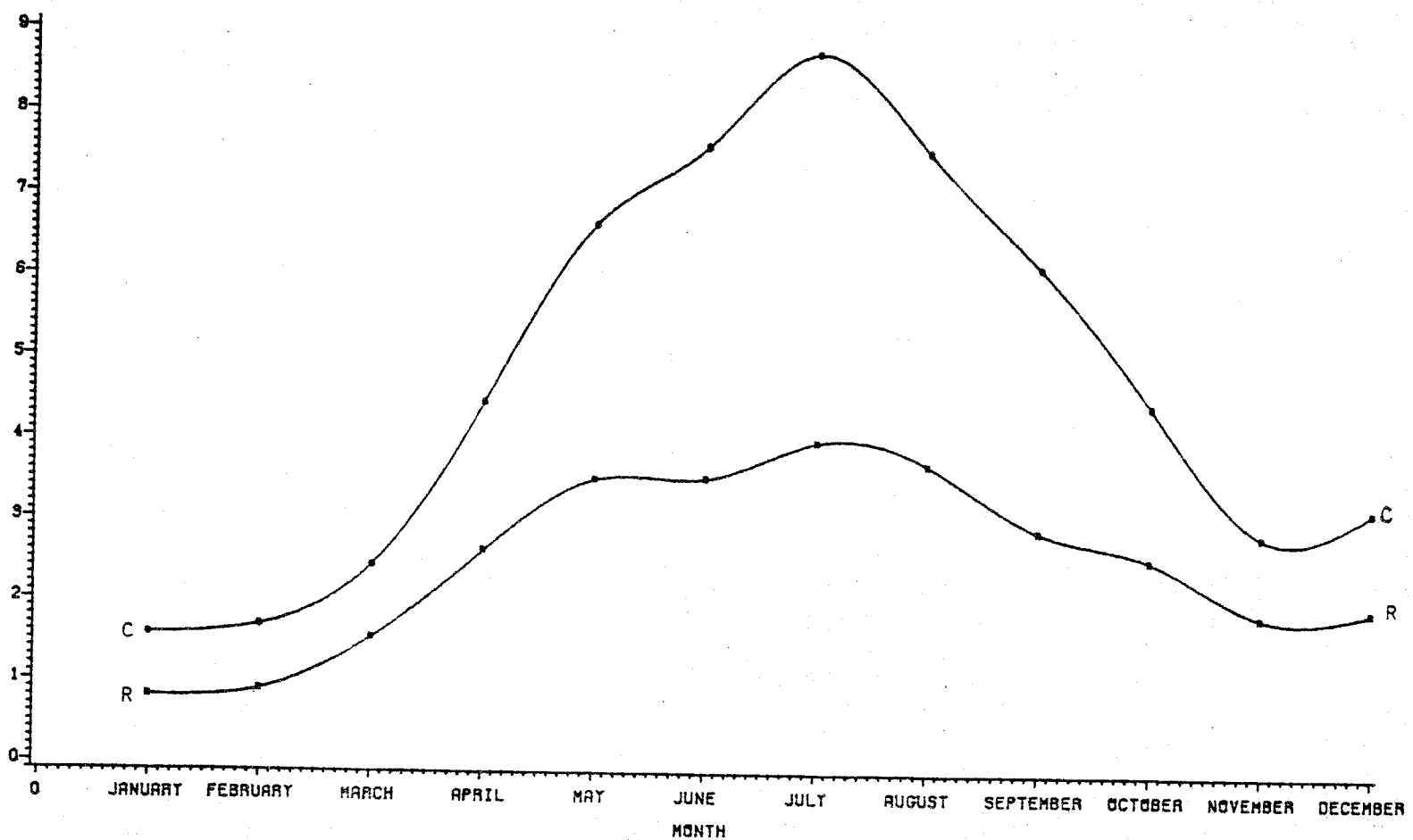

Figure 5.--Ono monthly landings statewide. Catch (C) in thousands of pounds and revenue (R) in thousands of dollars. (Average 1949-78.)